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Original Communication

Sexual dimorphism of the mandible in a modern Egyptian population

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ABSTRACT

Although human sex difference are now better known worldwide, there are few osteometric studies designed for sex assessment in Egyptians. The current study is the first to be conducted on this population to evaluate sex determination using osteometric mandibular measurements. By the use of spiral CT scan with three dimension reconstruction modality six mandibular measurements were assessed in 330 person (165 males and 165 females). These were subjected to statistical analysis. Many variables showed significant differences and included: bicondylar breadth, gonial angle and minimum ramus breadth. The study concluded that the overall predictive accuracy of this prediction model was 83.9% for whole studied persons. The correct predictive accuracy was 83.6% in males and 84.2% in females.

1. Introduction

It is a well known fact that skeletal attributes vary among different populations and that each therefore needs its own specific standards of assessment.[1–4] Many studies have been conducted in forensic anthropology examining several cephalo-facial characteristics.[5,6] Dimorphic criteria have been reported relative to the mandibular bone such as gonial angle, the ramus length, minimum ramus breadth, bigonial breadth and bicondylar breadth.[7–9]

Yet, there is no available specific data for sex assessment of Egyptians, nor previously systematic researches in the literature have been conducted considering these measurements in this population. Consequently, the objective of this study is to evaluate sexual dimorphism in the mandible of Egyptians using mandibular osteometric measurements.

2. Methodology

The study comprised 500 persons (250 males and 250 females). Their ages ranged from 6 to 60 years. They were selected from the dental section in EL. Zahraa Hospital in El. Azhar University for Girls in Cairo. A full history was taken from each case including: their age, mandible pathology, previous fracture(s), chronic inflammation or malunion. Consequently, 170 persons were excluded due to unknown age or due to obvious mandibular pathology, fracture or malunion. The remaining 330 persons (165 males and 165 females) were submitted to three-dimensional (3D) spiral computed tomographic (CT) images (Siemens® Machine Somatom ARSP) with the following parameters: 2 mm of slice thickness, interscan spacing 2 mm, slide reconstruction 1 mm, gantry rotation time 1.9 s time, field of view 162 mm, center $X = 0$, center $Y = -39$, using 130 kvp, 63 mA and matrix 512×512.

Six mandibular measurements were described according to Krogman and Iscan.[3] Four of them were measured from the lateral reconstruction CT image and they are gonial angle (G-angle), ramus length (Ramus-L), Minimum ramus breadth (M-Ramus-Br) and mandibular base length, i.e. gonion–gnathion length (G–G-L) as shown in Fig. 1. The other two measurements were computerized measured from the axial reconstruction image and they are bigonial breadth (BG-Br) and bicondylar breadth (BIC-Br) as shown in Fig. 2. Collected data were analyzed using SPSS statistical analysis program. (Frequency tables and descriptive measures for all continuous data, independent *t*-test, chi-square test and discriminant analysis with "the stepwise feature being used to choose the most discriminatory variables".)

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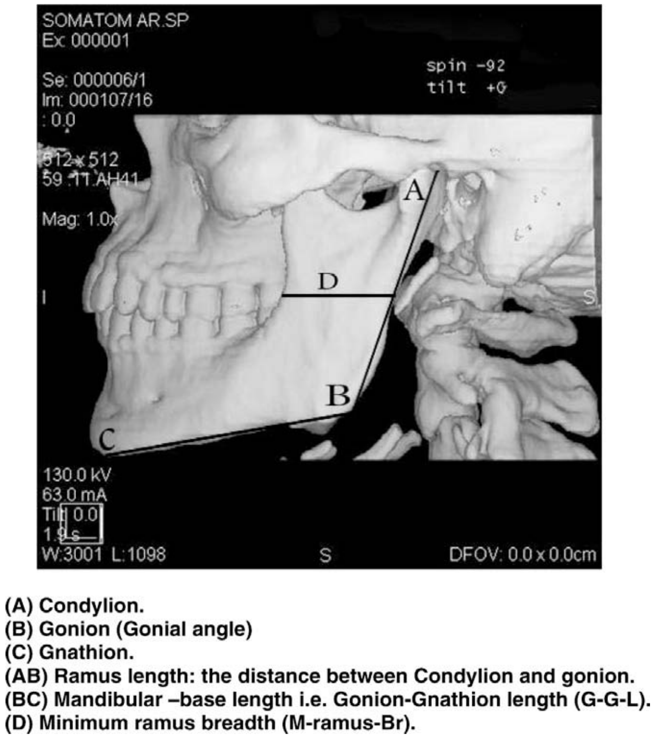

Fig. 1. (A) Condylion; (B) Gonion (gonial angle); (C) Gnathion; (AB) ramus length: the distance between condylion and Gonion; (BC) Mandibular – base length, i.e. Gonion–Gnathion length (G–G-L); (D) minimum ramus breadth (M-Ramus-Br).

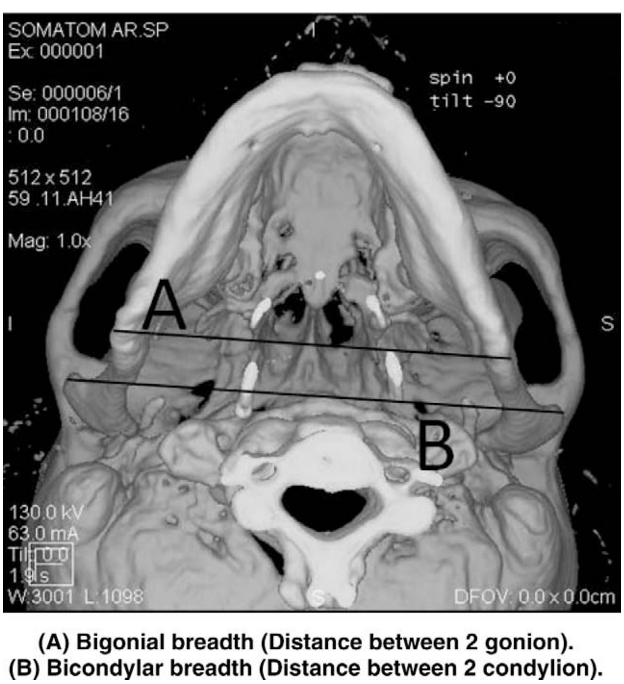

Fig. 2. (A) Bigonial breadth (distance between two Gonion); (B) bicondylar breadth (distance between two condylion).

3. Results

As a first step to determined sex from mandible the student's *t*-test was done to compare the mean values of the different mandibular measurements between the studied males and females (Table 1) and which included: the bigonial breadth (BG-BR), bicondylar breadth (BIC-BR), gonial angle (G-angle), gonion–gnathion length (G–G-L), minimum ramus breadth (M-Ramus-Br) and ramus length (Ramus-L).

It was evident that from the six studied mandibular measurements, three of which showed mean values which were significantly different between males and females. These are: the bicondylar breadth (BIC-Br) in which the mean value in males (108.9 ± 7.7) was significantly higher than in females (99.6 ± 6.4) with $P < 0.0001$. In addition, the mean value of the gonial angle (G-angle) in males (122.8 ± 4.3°) was significantly greater than that in females (121.8 ± 3.9°), with $P < 0.0001$. Also, the mean value of the minimum ramus breadth (M-Ramus-Br) in males (28.7 ± 2.4 mm) was significantly higher than that in females (27.96 ± 2.4 mm), with $P < 0.0005$.

The second step is a trial to define the best predictors of sex discrimination using the stepwise Discriminant Analysis Test (Table 2). The study identified four mandibular measurements as a final predictors of sex determination which are: the bicondylar breadth (BIC-Br), gonion angle (G-angle), minimum ramus breadth (M-Ramus-Br) and ramus length (Ramus-L). The test showed that the Wilks' Lambda value was 0.554 which implied high predictability with $P < 0.00001$.

Table 1
The mean value ± standard deviation (SD) of the six mandibular measurements compared between males and females using the student's *t*-test.

Variable	Sex	*N*	Mean ± SD	*T*-value	*P*-value
BG-Br	M	165	104.8 ± 7.5	0.995	$P > 0.05$
	F	165	100.8 ± 66.3		NS
Bic-Br	M	165	108.9 ± 7.7	3.737	<0.0001*
	F	165	99.6 ± 6.4		
G-angle	M	165	122.8 ± 4.3	3.365	<0.0001*
	F	165	121.1 ± 3.9		
G–G-L	M	165	76.2 ± 5.6	0.587	$P > 0.05$
	F	165	83.1 ± 81.2		NS
M-Ramus-Br	M	165	28.7 ± 2.4	3.487	<0.005*
	F	165	27.96 ± 2.4		
Ramus-L	M	165	65.1 ± 7.3	0.378	$P > 0.05$
	F	165	64.7 ± 7.6		NS

$P > 0.05$: non-significant (NS).
* $P < 0.05$: significant.

Table 2
Final predictors for sex determination using stepwise discriminant analysis for the whole studied group.

Variables entered	Wilks' Lambda	Chi-square	*df*	*P*-value
Bic-Br G-angle M-Ramus-Br Ramus-L	0.554	198.7	4	0.00001*

Wilks' Lambda close to zero implies high predictability, while value closer to one implies low predictability.
* $P < 0.05$: significant, *df*: degree of freedom.

Table 3
Classification matrix for males and females using stepwise discriminant analysis.

Sex	Original	Predicted group		Accuracy	
		M	F	(Correct) true +ve (%)	(Incorrect) false −ve (%)
M	165	138	26	83.6	16.4
F	165	27	139	84.2	15.8

Overall predictive accuracy 83.9%.

Using the previous four mandibular measurements as final predictors of sex determination, it was found that the overall predictive accuracy of this prediction model was 83.9% for whole studied group (330 persons). It could correctly identify males in 83.6% and females in 84.2% cases. False identification of males occurred in 16.4% versus 15.8% in females as shown in Table 3.

4. Discussion

In the current study, it was evident that from the six studied mandibular measurements that three of them showed significantly higher mean values in males than in females. These were: bicondylar breadth, gonial angle and minimum ramus breadth. In a trial to define the best predictor of sex determination, the stepwise feature discriminant analysis could identify bicondylar breadth, gonial angle, minimum ramus breadth and ramus length as final predictors of sex determination with overall predictive accuracy of 83.9% for whole group (330 persons). It could identify males correctly in 83.6% and females in 84.2%.

Unfortunately, no systematic investigations or previous article in the literature have been conducted with regard to these measurements in Egyptian population.

Generally, the percentage accuracy obtained in current study is comparable to that for other studies. A discriminant function analysis was used to study white South Africans to establish which mandibular measurements give most information about the differences between males and females. Bigonial breadth was selected as the most discriminatory and obtained average accuracies of 82% for mandible.[9] It is interesting to note that, in the current study, bigonial breadth was not very dimorphic when sex determination was done for whole cases from 6–60 years old.

Iscan et al.[4] found accuracies of 84.1% (cranium and mandible) and 83.7% (cranium only) in Japanese skulls as compared to 83.9% for mandibles from the current study. By studying black South Africans, Kieser and Groeneveld[10] found 91% accuracies with combination of two maxillary and two mandibular measurements and 78% accuracy when only gonion–gnathion length was used.

5. Conclusion and recommendations

This study has provided a preliminary evaluation for some osteometric standards designed for sex assessment from the mandible in Egyptians.

We advocate the importance of conducting further comprehensive studies on a larger number of cases, larger age scales, and different governorates in Egypt to obtain results which can be used to identify sex with more exactitude. In addition, further studies are needed to develop a group specific standard for identification of individuals because of the great variation which might be present between different population groups, e.g. occupation and ethnic difference which will affect the skeleton and consequently bone measurements.

There is also a great need for greater awareness in forensic circles and police doctors in Egypt of the identifying power of CT scan as it is an available, relatively cheap, replicable and non-invasive method for human identification.

Conflict of Interest

None declared.

Funding

None declared.

Ethical Approval

Written consent was taken from each subject in the study and no ethical Approval was needed from any other authority.

References

1. Iscan MY, Miller-Shaivitz P. Sexual dimorphism in the femur and tibia. In: Reichs KJ, editor. *Forensic osteology: advances in the identification of human remains*. Springfield (IL): Charles C. Thomas; 1986. p. 102–11.
2. Gill GW, Rhine S, editors. *Skeletal attribution of race: methods for forensic anthropology, anthropological papers no. 4*. Maxwell Museum of Anthropology, Albuquerque; 1990.
3. Krogman WM, Iscan MY. *The human skeleton in forensic medicine*. Springfield (IL): Charles C. Thomas; 1986.
4. Iscan MY, Yoshino M, Kato S. Sexual dimorphism in modem Japanese crania. *Am J Hum Biol* 1995;**7**:459–64.
5. Iscan MY. Forensic anthropology of sex and body size. *Forensic Sci Int* 2005;**147**:107–12.
6. Patil KR, Mody RN. Determination of sex and body by discriminant function analysis and stature by regression analysis: a lateral cephalometric study. *Forensic Sci Int* 2005;**147**:175–80.
7. Giles E. Sex determination by discriminant functions, analysis of mandibular shape. *J Craniofacial Genet Dev Biol* 1996;**16**:208–17.
8. Iscan MY, Steyn M. Craniometric determination of population affinity in South Africans. *Int J Legal Med* 1999;**112**:91–7.
9. Steyn M, Iscan MY. Sexual dimorphism in the crania and mandibles of South African Whites. *Forensic Sci Int* 1998;**98**:9–16.
10. Kieser JA, Groeneveld HT. Multivariate sexing of the human viserocranium. *J Forensic Odontostomatol* 1986;**4**:41–6.